Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

Summer Examinations, 2009/2010

Exam Code(s)	4IF
Exam(s)	B.Sc. Information Technology
Module Code(s)	CT420
Module(s)	Real Time Systems
Paper No.	1
Repeat Paper	no Special Paper
External Examiner(s)	Prof. Michael O Boyle
Internal Examiner(s)	Prof. Gerard Lyons Dr. Jim Duggan Dr. Michael Schukat Dr. Hugh Melvin
Instructions:	Answer Q1 and **any other** 3 questions. All Q carry equal marks.
Duration	3 hrs
No. of Answer books	1
Requirements:	
Handout	
MCQ	
Statistical Tables	
Graph Paper	
Log Graph Paper	
Other Material	
No. of Pages	4
Department(s)	Information Technology

Q1. (i) Distinguish using examples between a Hard and Soft RTS. Explain why many Hard RTS use a cyclic executive approach to scheduling whereas many Soft RTS utilise a RealTime Operating System. Comment also on the relationship between the *sample rate* and *response time* for a RTS.

(15)

(ii) Briefly compare and contrast the Cyclic Executive approach and Multiple Process approach to scheduling for Real Time Systems, commenting on where each might best be deployed.

(10)

(iii) As senior network advisor, you are asked to test/evaluate a range of new VoIP phones for your organisation. Describe using diagrams a testbed that you might develop for this purpose and what metrics you would use for your tests.

(15)

Q2. (i) Distinguish between **time and timing** synchronisation and explain using examples why both can be important for Real Time Systems.

(10)

(ii) Outline briefly at a high level how computer system clocks work. Compare and contrast the various options that a system designer has in terms of timing sources.

(15)

(iii) As a network administrator, you need to ensure that all servers within your organisations *Wide Area Network* are tightly synchronised to within +/-5 msec on a 24/7 basis. Briefly sketch and describe your design for an NTP subnet to meet this requirement, commenting on all relevant issues (Stratum sources, redundancy, OS platform, network issues etc).

(10)

Show using an example how network asymmetry can seriously degrade NTP performance.

(5)

Q3. The International Space Station (ISS) is one of the most expensive and most challenging engineering projects ever conducted. In this question you will discuss various RTS aspects of this system.

i) The crew of the ISS conducts a series of experiments, the results of which are stored in a server on board the station. Identify environmental challenges for both the primary (e.g. RAM) and secondary (e.g. hard disk) server storage and discuss in detail how information redundancy on both levels can be increased. (15)

ii) One of the most important subsystems of the ISS is its control momentum gyroscope (CMG) that monitors the position and orientation of the station, therefore holding it at a fixed attitude relative to the surface of the earth. The CMG consists of a sensor section (e.g. gyroscope) and a control section (e.g. computer). Discuss 4 (hypothetical) system failure scenarios and outline how appropriate hardware and software fault tolerant techniques / redundancy can be used for their prevention. (15)

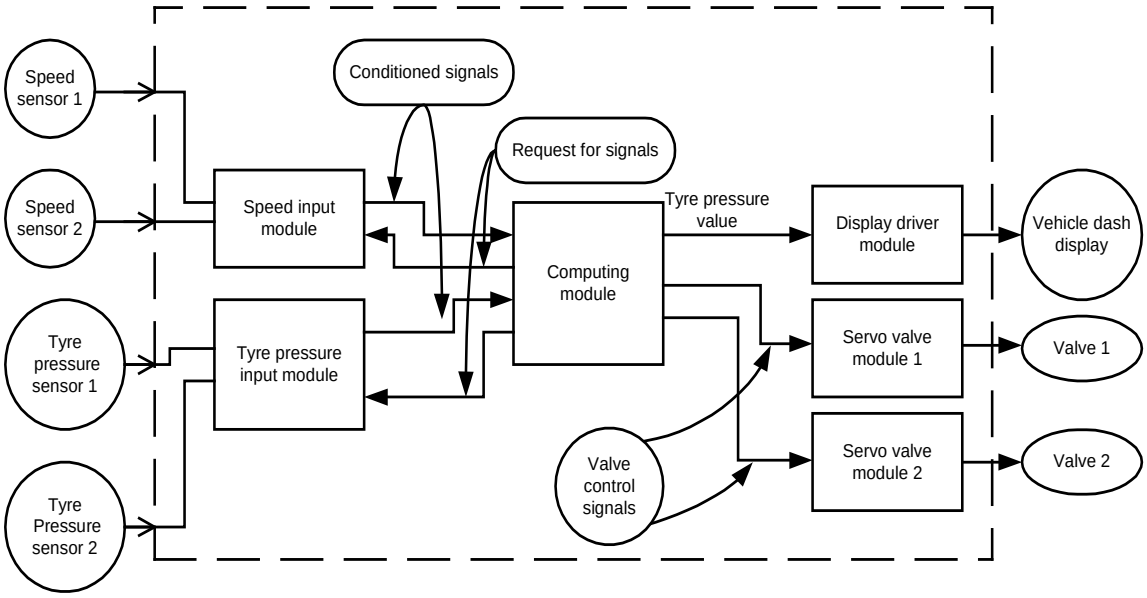
iii) The ISS has a radio data link (based on a network of communication satellites) to the Payload Operations Center at the Marshall Space Flight Center in Huntsville, Alabama. This "science command post" links earth-bound researchers around the world with their experiments and astronauts aboard the ISS. The communication link itself is based on TCP over IP. What are the benefits and limitations of TCP/IP in such an environment and what other means of transmission and information redundancy would you suggest to use? (10)

Q4. The diagram overleaf shows a tyre pressure monitoring system (PMS) as deployed in a high-end motorbike. The system continuously measures and controls the (speed dependent) optimal pressure of both tyres via a set of pressure sensors and servo valves. The dash display provides additional information.

i) Distinguish between 5 tasks for the PMS software (to be executed by the computing module in the centre of the diagram) and assign meaningful (and unique!) periods and execution times to them. (10)

ii) Using the task structure in i) implement a Cyclic Executive and calculate its time line. Discuss a situation where execution deadlines are not met and provide a solution. (10)

iii) Enhance your task structure in i) by adding meaningful (and unique!) task priorities. Show how rate-monotonic (RM) scheduling and earliest deadline first (EDF) scheduling will handle the task execution. (20)



Q5.

i) Briefly outline the role of POSIX in Operating System design. (10)

ii) You are asked to develop a safety critical application that is required to run on a conventional Linux OS that supports many POSIX.4 features. Explain what POSIX.4 features you would use, how you would use them, commenting also on your choice of programming language. (30)

Q6. (i) Explain in detail how the Internet multimedia protocols RTP and its companion RTCP as well as Packet Loss Concealment (PLC) and Forward Error Correction (FEC) strategies help to deal with the fundamental non-determinism and unreliable nature of UDP-based multimedia delivery over the public Internet. In particular, comment on the challenge of implementing so-called lip-synch.

(25)

(ii) The design of jitter buffers is a key factor in delivering adequate QoS across non-deterministic packet networks. Discuss.

(15)